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A. D. MELVIN, CHIEF OF BUREAU.

A HUMIDITY REGULATOR.[1]

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The necessity for accurate control of temperature in the study of chemical reactions has been the mother of numerous inventions for the automatic maintenance of constant temperature. But the maintenance of constant humidity has been left largely to the ingenuity

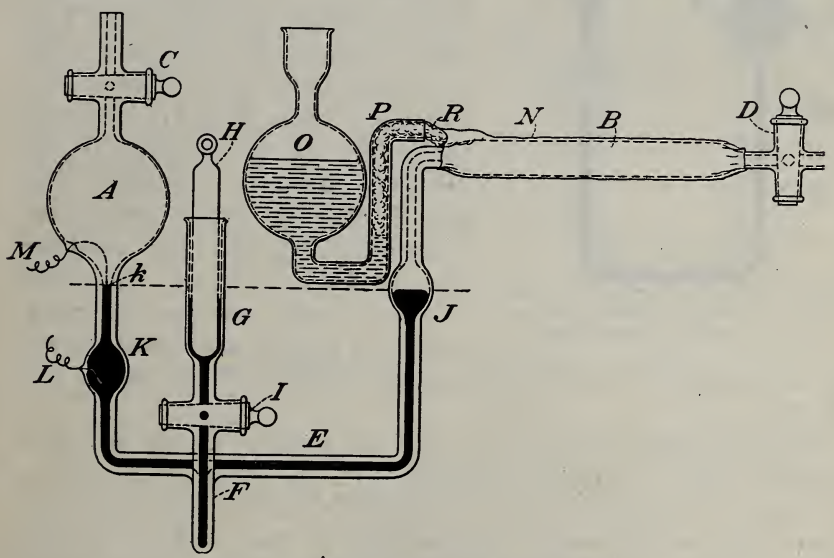

FIG. 1.—Humidity regulator, general view.

of those who are interested in the textile industries and in cold storage, and the scientific investigator is without an instrument which he can make for himself and depend upon in his studies of the development of plant life or of any phenomena influenced by the humidity of the surrounding air.

[1] In accordance with the requirements of the Department of Agriculture the apparatus herein described has been patented and the patent dedicated to the public. The patent is No. 1,042,893, issued Oct. 29, 1912.

In the ripening of cheese humidity plays a very important rôle, and it was in connection with this that the regulator herein described was devised. A description of the apparatus is given in the hope that its accuracy and simplicity as well as the ease with which it can be made will commend it to those who need such an instrument.

A general view of the apparatus is shown in figure 1. Figure 2 is a sectional view of the capillary connections.

DESCRIPTION OF THE APPARATUS.

The regulator operates on the principle of the wet and dry bulb hygrometer. It consists of a dry bulb *A* and a bulb *B* kept moist by a thin covering of wicking or muslin. This is fed with water from the reservoir *O*. For convenience in adjusting as well as for cleaning and filling both bulbs are provided with cocks, *C* and *D*.

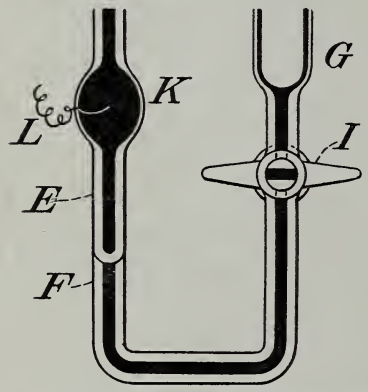

FIG. 2.—Humidity regulator, sectional view of capillary connections.

In order to present a convenient as well as a large surface, *B* is made cylindrical. The bulbs *A* and *B* are connected by the capillary tube *E*, partially filled with mercury. This tube is connected by a T-joint, *F*, to a leveling bulb, or preferably to a cup and plunger, *G* and *H*, by which the height of the mercury in the capillary may be adjusted. The cock *I* serves to open or break communication between the capillary and the leveling device. The bulbs *J* and *K* serve as mercury reservoirs and prevent accidental emptying of the capillary and consequent interchange of the gases in *A* and *B*.

Electrical connection is made with the mercury by the sealed-in platinum wire *L*. Another platinum wire, *M*, is sealed in in such a way that its fused and smooth tip extends into the capillary at *k*. These wires are connected with a battery and relay, and are spanned with a condenser and a by-pass in order to eliminate sparking at the contact *k*.

METHOD OF OPERATION.

The operation of the regulator is as follows: The whole instrument is placed in a current of air whose humidity it is desired to regulate. Evaporation takes place on the moist bulb *B*, producing a cooling of the inclosed gas. The consequent reduction in pressure permits the excess pressure in *A* to drive the mercury away from the platinum contact at *k*. By this break in the circuit the relay is released in such

a way that there is actuated a steam or water spray or a heating unit for raising the vapor tension of a body of water over which the air flows. As the humidity of the air is thus increased the evaporation from B diminishes, and consequently the cooling. The pressure in B therefore regains its former value and contact is again made at k, the relay is actuated, and the source of moisture is shut off. For laboratories having electric current it will probably be found convenient to raise the vapor pressure by having the relay control an electric immersion heater plunged in a small vessel of water, and to have this vessel kept at constant water level, as is the Victor Meyer water bath.

If the space whose humidity it is desired to control is not to be kept at constant temperature, and constant relative humidity is still demanded, it should be remembered that for a given relative humidity the temperature of the wet bulb will increase less rapidly than that of the dry bulb, with a rising temperature. Compensation for this can not be made by varying the relative sizes of the two bulbs, but it can be done by adjusting the pressures within the two bulbs.

To find the conditions to be established if it is desired to maintain a constant relative humidity we apply the following considerations: Since the circuit controlling the humidifier is made and broken at the point k, the volumes of the gas in the two bulbs must be kept constant, and in order that the mercury column may not be displaced any increment of pressure in the one bulb must be compensated for by an equal increment of pressure in the other.

Let T =the absolute temperature of the dry bulb.

T′=the absolute temperature of the wet bulb for a given relative humidity at temperature T.

Let T increase by $\triangle$T and T′ by $\triangle$T′, when the same relative humidity is maintained.

Let P =the initial pressure of the dry bulb at T.

P′=the initial pressure of the wet bulb at T′.

When T increases by $\triangle$T, P increases by $\triangle$P.

When T′ increases by $\triangle$T′, P′ increases by $\triangle$P′.

As mentioned above, the condition desired is that $\triangle P = \triangle P'$.

From the equation for a gas at constant volume,

$$\frac{P}{P_2} = \frac{T}{T_2} \text{ and } \frac{P'}{P'_2} = \frac{T'}{T'_2},$$

where the subscripts represent the temperature and pressure under a second set of conditions, we may deduce the equation

$$\frac{P}{P'} = \frac{\Delta T' T}{\Delta T T'}$$

From this last equation we may calculate the pressure which must be imposed upon the gas in the wet bulb, provided we start with a known pressure of gas in the dry bulb and postulate the relative

The apparatus is by no means "foolproof," and no claims are made that it will be useful in careless hands. For the purpose for which it was designed it has proved satisfactory, in spite of the fact that the room in which it was used had paraffined walls with practically no moisture capacity, a condition extremely unfavorable for the maintenance of constant vapor pressure.

Approved.

JAMES WILSON,
Secretary of Agriculture.

WASHINGTON, D. C., *January 22, 1913.*

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